

In the Claims:

Please amend claims 1, 3, 7, 9, 14, 16, 17 and 19. Claims 22-60 are withdrawn. Please add new claims 61-65. The claims are as follows:

1. (Currently Amended) A method of manufacturing an interconnect, comprising:

- (a) providing a substrate;
- (b) forming a dielectric layer on said substrate;
- (c) forming a wire in said dielectric layer, a top surface of said wire coplanar with a top surface of said dielectric layer;
- (d) forming a first capping layer on said top surface of said wire and said top surface of said dielectric layer, ~~said first capping layer thin enough to allow penetration of said first capping layer by~~
- (e) pushing a point of a conductive probe tip through said first capping layer in order to make electrical contact to said wire, and then afterwards removing said conductive probe tip from said wire and said first capping layer; and
- (~~e~~) (f) after step (~~d~~) (e) forming a second capping layer on a top surface of said first capping layer.

2. (Original) The method of claim 1, wherein said wire includes copper exposed to an ambient atmosphere at said top surface of said wire.

3. (Currently Amended) The method of claim 2, wherein said first capping layer is ~~sufficiently thick to prevent~~ formation, on said top surface of said wire, of copper containing particles by reaction of said wire with said dielectric layer.
4. (Original) The method of claim 1, wherein said dielectric layer comprises fluorinated silicon glass.
5. (Original) The method of claim 4, wherein said dielectric layer comprises about 1% to about 9% by weight of fluorine.
6. (Original) The method of claim 4, wherein said wire includes copper exposed to an ambient atmosphere at said top surface of said wire.
7. (Currently Amended) The method of claim 6, wherein said first capping layer is ~~sufficiently thick to prevent~~ formation, on said top surface of said wire, of copper containing particles by reaction of copper in said wire with fluorine in said dielectric layer.
8. (Original) The method of claim 1, wherein said first capping layer and said second capping layer independently include a material selected from the group consisting of Si_xN_y , Si_xC_y , SiC_xH_y , $\text{SiC}_x\text{O}_y\text{N}_z$ and SiC_xN_y .
9. (Currently Amended) The method of claim 1, wherein said first capping layer and said second capping layer each independently include one two or more layers of materials, each layer of said

two or more layers of said first and second capping layers independently including materials
selected from the group consisting of Si_xN_y , Si_xC_y , SiC_xH_y , $\text{SiC}_x\text{O}_y\text{N}_z$ and SiC_xN_y .

10. (Original) The method of claim 1, wherein said first capping layer has a thickness between about 100 Å and 300 Å.

11. (Original) The method of claim 1, wherein said second capping layer has a thickness between about 150 Å and 700 Å.

12. (Original) The method of claim 1, wherein said second capping layer is a copper diffusion barrier.

13. (Original) The method of claim 1, wherein said first capping layer in combination with said second capping layer is a copper diffusion barrier.

14. (Currently Amended) The method of claim 1, further including:

~~(g)~~ (f) forming another dielectric layer on a top surface of said second capping layer, said second capping layer acting as a reactive ion etch stop for etching said another dielectric layer.

15. (Original) The method of claim 1, wherein forming said first capping layer comprises forming silicon nitride by high density plasma deposition and forming said second capping layer comprises forming silicon nitride formed by plasma enhanced chemical vapor deposition.

16. (Currently Amended) The method of claim 1, further including between steps ~~(d)~~ and (e) and (f), cleaning said top surface of said first capping layer.

17. (Currently Amended) The method of claim 1, further including between steps ~~(d)~~ and (e) and (f), cryogenically cleaning said top surface of said first capping layer.

18. (Original) The method of claim 1, further including between steps (c) and (d), cleaning said top surface of said wire and said top surface of said dielectric layer in a reducing environment.

19. (Currently Amended) The method of claim 1, further including between steps ~~(d)~~ and (e) and (f), performing one or more characterization procedures selected from the group consisting of optical or SEM inspection and optical or SEM image size measurement.

20. (Original) The method of claim 1, wherein said first capping layer is thin enough to be transparent to visible light, to back-scattered electrons in a SEM or to both.

21. (Original) The method of claim 1, wherein said second capping layer is formed at a temperature of about 350°C or greater.

22. (Previously Presented and Withdrawn) A method of manufacturing a structure, comprising:

- (a) providing a substrate;
- (b) forming a copper diffusion barrier layer on said substrate;
- (c) forming a dielectric layer on a top surface of said copper diffusion barrier layer;

(d) forming a copper damascene or dual damascene wire in said dielectric layer, a top surface of said copper damascene or dual damascene wire coplanar with a top surface of said dielectric layer;

(e) forming a first capping layer on said top surface of said wire and said top surface of said dielectric layer;

(f) after step (e) performing one or more characterization procedures in relation to said structure; and

(g) after step (f) forming a second capping layer on said top surface of said first capping layer.

23. (Previously Presented and Withdrawn) The method of claim 22, wherein said dielectric layer comprises fluorinated silicon glass.

24. (Previously Presented and Withdrawn) The method of claim 23, wherein said dielectric layer comprises about 1% to about 9% by weight of fluorine.

25. (Previously Presented and Withdrawn) The method of claim 24, wherein said first capping layer is sufficiently thick to prevent formation, on said top surface of said wire, of copper containing particles by reaction of copper in said wire with fluorine in said dielectric layer.

26. (Previously Presented and Withdrawn) The method of claim 22, wherein said first capping layer and said second capping layer independently include a material selected from the group consisting of Si_xN_y , Si_xC_y , SiC_xH_y , $\text{SiC}_x\text{O}_y\text{N}_z$ and SiC_xN_y .

27. (Previously Presented and Withdrawn) The method of claim 22 wherein said first capping layer and said second capping layer independently include one or more layer of materials selected from the group consisting of Si_xN_y , Si_xC_y , SiC_xH_y , $\text{SiC}_x\text{O}_y\text{N}_z$ and SiC_xN_y .

28. (Previously Presented and Withdrawn) The method of claim 22, wherein said first capping layer has a thickness between about 100 Å and 300 Å.

29. (Previously Presented and Withdrawn) The method of claim 22, wherein said second capping layer has a thickness between about 150 Å and 700 Å.

30. (Previously Presented and Withdrawn) The method of claim 22, wherein said second capping layer is a copper diffusion barrier.

31. (Previously Presented and Withdrawn) The method of claim 22, wherein said first capping layer in combination with said second capping layer is a copper diffusion barrier.

32. (Previously Presented and Withdrawn) The method of claim 22, further including:

(h) forming another dielectric layer subsequently formed on a top surface of said second capping layer, said second capping layer acting as a reactive ion etch stop for etching said another dielectric layer.

33. (Previously Presented and Withdrawn) The method of claim 22, wherein forming said first capping layer comprises forming silicon nitride by high density plasma deposition and forming said second capping layer comprises forming silicon nitride by plasma enhanced chemical vapor deposition.

34. (Previously Presented and Withdrawn) The method of claim 22, further including between steps (f) and (g), cryogenically cleaning said top surface of said first capping layer.

35. (Previously Presented and Withdrawn) The method of claim 22, further including between steps (d) and (e), cleaning said top surface of said wire and said top surface of said dielectric layer in a reducing environment.

36. (Previously Presented and Withdrawn) The method of claim 22, wherein said one or more characterization procedures are selected from the group consisting of optical or SEM inspection, optical or SEM image size measurement and electrical probing.

37. (Previously Presented and Withdrawn) The method of claim 22, wherein said first capping layer is thin enough to be transparent to visible light, to back-scattered electrons in a SEM or to both.

38. (Previously Presented and Withdrawn) The method of claim 22, wherein said first capping layer is thin enough to allow penetration of said first capping layer by a point of a conductive probe tip in order to make electrical contact to said wire.

39. (Previously Presented and Withdrawn) A structure, comprising:

a copper damascene or dual damascene wire in a fluorinated silicon glass dielectric layer,
a top surface of said copper damascene or dual damascene wire coplanar with a top surface of
said fluorinated silicon glass dielectric layer;

a first capping layer formed on said top surface of said copper damascene or dual
damascene wire and said top surface of said fluorinated silicon glass dielectric layer; and

a second capping layer formed on said top surface of said first capping layer, said first
capping layer thin enough to allow performance of one or more characterization procedures in
relation to said structure and thick enough to prevent formation, on said top surface of said
copper damascene or dual damascene wire, of copper containing particles by reaction of copper
in said copper damascene or dual damascene wire with fluorine in said fluorinated silicon glass
dielectric layer.

40. (Previously Presented and Withdrawn) The structure of claim 39, wherein said fluorinated
silicon glass dielectric layer comprises about 1% to about 9% by weight of fluorine.

41. (Previously Presented and Withdrawn) The structure of claim 39, wherein said first capping
layer and said second capping layer independently include a material selected from the group
consisting of Si_xN_y , Si_xC_y , SiC_xH_y , $\text{SiC}_x\text{O}_y\text{N}_z$ and SiC_xN_y .

42. (Previously Presented and Withdrawn) The structure of claim 39, wherein said first capping layer and said second capping layer independently include one or more layer of materials selected from the group consisting of Si_xN_y , Si_xC_y , SiC_xH_y , $\text{SiC}_x\text{O}_y\text{N}_z$ and SiC_xN_y .

43. (Previously Presented and Withdrawn) The structure of claim 39, wherein said first capping layer has a thickness between about 100 Å and 300 Å.

44. (Previously Presented and Withdrawn) The structure of claim 39, wherein said second capping layer has a thickness between about 150 Å and 700 Å.

45. (Previously Presented and Withdrawn) The structure of claim 39, wherein said second capping layer is a copper diffusion barrier.

46. (Previously Presented and Withdrawn) The structure of claim 39, wherein said first capping layer in combination with said second capping layer is a copper diffusion barrier.

47. (Previously Presented and Withdrawn) The structure of claim 39, wherein said one or more characterization procedures are selected from the group consisting of optical or SEM inspection, optical or SEM image size measurement and electrical probing.

48. (Previously Presented and Withdrawn) The structure of claim 39, wherein said first capping layer is thin enough to be transparent to visible light, to back-scattered electrons in a SEM or to both.

49. (Previously Presented and Withdrawn) The structure of claim 39, wherein said first capping layer is thin enough to allow penetration of said first capping layer by a point of a conductive probe tip in order to make electrical contact to said copper damascene or dual damascene wire.

50. (Withdrawn) A method of manufacturing an interconnect, comprising:

- (a) providing a substrate;
- (b) forming a copper wire in a dielectric layer, said dielectric layer having a top surface;
- (c) exposing a copper top surface of said copper wire, said copper top surface of said copper wire coplanar with said top surface of said dielectric layer or exposing said copper top surface of said copper wire in a bottom of a trench formed in said dielectric layer;
- after step (c), (d) storing said substrate in a controlled environment; and
- after step (d), (e) performing further processing steps on said substrate.

51. (Previously Presented and Withdrawn) The method of claim 50, wherein said dielectric layer comprises fluorinated silicon glass.

52. (Previously Presented and Withdrawn) The method of claim 50, wherein said controlled environment is selected from the group consisting of humidity controlled environment, temperature controlled environments, inert gas environments, non-oxygen containing environments and combinations thereof.

53. (Previously Presented and Withdrawn) The method of claim 50, wherein said controlled environment has a relative humidity of about 20% or less at a temperature of about 70°F or less.

54. (Previously Presented and Withdrawn) The method of claim 50, wherein said controlled environment comprises H₂, He, Ar, N₂, combinations H₂, He, Ar, N₂, or air with a relative humidity of about 20% or less.

55. (Withdrawn) A method of manufacturing an interconnect, comprising:

- (a) providing a substrate;
- (b) forming a copper wire in a dielectric layer, said dielectric layer having a top surface;
- (c) exposing a copper top surface of said copper wire, said copper top surface of said copper wire coplanar with said top surface of said dielectric layer or exposing said copper top surface of said copper wire in a bottom of a trench formed in said dielectric layer to an ambient atmosphere for a period of time;
 - after step (c), (d) if said period of time exceeds a predetermined period of time, performing a rework clean or a rework chemical mechanical polish; and
 - after step (d), (e) performing further processing steps on said substrate.

56. (Previously Presented and Withdrawn) The method of claim 55, wherein said dielectric layer comprises fluorinated silicon glass.

57. (Previously Presented and Withdrawn) The method of claim 55, wherein step (e) includes forming a capping layer over said dielectric layer.

58. (Previously Presented and Withdrawn) The method of claim 55, wherein said rework clean includes etching in an aqueous solution containing HF.

59. (Previously Presented and Withdrawn) The method of claim 55, wherein formation of said copper wire includes a first chemical mechanical polish of a copper layer formed over a non-copper liner layer followed by a second chemical mechanical polish of said liner layer; and wherein said rework chemical mechanical polish is the same process as said second chemical mechanical polish for about the same or less time.

60. (Previously Presented and Withdrawn) The method of claim 55, further including:

after step (e), (f) determining an elapsed time from formation of said capping layer to a present time;

after step (f), (g) if said elapsed time exceeds a additional predetermined period of time, performing a cryogenic clean; and

after step (g), (h) forming an additional capping layer on a top surface of said capping layer.

61. (New) The method of claim 1, wherein said wire comprises copper and said dielectric layer comprises fluorinated silicon glass, said first capping layer preventing formation, on said top surface of said wire, of copper oxy fluoride particles by reaction of said wire with said dielectric layer.

62. (New) The method of claim 1, wherein said wire comprises copper and said dielectric layer comprises fluorinated silicon glass, said first capping layer preventing formation, on said top surface of said wire, of $N_xH_yF_z$ containing particles by reaction of said wire with said dielectric layer.

63. (New) The method of claim 1, further including between steps (e)b and (f), cryogenically cleaning said top surface of said first capping layer by spraying said top surface of first capping layer with particles of CO_2 , Ar or N_2 .

64. (New) The method of claim 1, wherein said first capping layer and said second capping layer independently include a material selected from the group consisting of SiC_xH_y , $SiC_xO_yN_z$ and SiC_xN_y .

65. (New) The method of claim 1, further including between steps (c) and (d), cleaning said top surface of said wire and said top surface of said dielectric layer in reducing plasma environment.